

GUJARAT UNIVERSITY

Syllabus for Third Year B. Sc. Microbiology

Effective from June 2004

1. A student offering microbiology as a special subject will offer theory Papers VI, VII, VIII, IX and X, each paper being of 100 marks and practical papers I, II, and III of total 250 marks, as prescribed here under.
2. Each theory paper, at the external examination shall be of three hours duration and carry 70 marks. Each practical examination shall be for three consecutive days, each of seven hours duration.
3. Internal assessment will be from 30 marks for each theory paper and 75 marks for practical.
4. For each theory paper, there will be three lecture periods of 55 minutes per week For practicals there will be 16 practical periods, each of 55 minutes per week.
5. Each theory paper has been divided in to five units as mentioned, from each unit, one question shall be set.
6. Practical batch will be consisting of maximum 15 students.
7. The teaching base should be from all the listed text books.

Paper VI : Bacterial Genetics and Molecular Biology

Unit 1 : [A] Introduction to bacterial genetics

- (a) Principles of inheritance - relevance of Mendelian laws.
- (b) Nature of genetic material : gene structure and function, arrangement and linkage, gene complementation, cistron, concept of intron and exon, one gene one poly peptide theory, organization of bacterial chromosome. Microorganisms as a genetic tools.

[B] Replication of DNA

- (a) Semi-conservative mode of chromosome replication, work of Messelson and Stahl
- (b) Molecular mechanism of chromosome replication, origin of replication, mode of formation of replication fork and its growth, post replicative modification of DNA.
- (c) Models of chromosome replication - Cairn's model and Rolling circle model

Unit 2 : Gene expression and its regulation

- (a) Concept of central dogma
- (b) Gene transcription as the 1st step of gene expression, molecular mechanism of transcription, role of RNA polymerase, initiation, elongation and termination of RNA synthesis, post transcriptional modifications in bacteria.
- (c) Nature of Genetic Code – characteristics of genetic code – triplet, degeneracy, Wobble Hypothesis. Deciphering genetic code, work of Nirenburg, Holley and Khorana
- (d) Gene translation :
 - Ribosomes - their general nature, structure and role in protein synthesis
 - Type of RNAs involved in protein synthesis, structure and function of tRNA
 - Initiation, elongation, and termination of protein synthesis, post translational processing
 - Protein localization - export of protein, role of signal peptides.
- (e) Regulation of Gene expression
 - Operon model
 - Regulation of inducible and constitutive genes

- Positive and negative control, catabolic repression, variation in sigma factor and promoter in gene regulation
- Introduction to other patterns of gene regulation

Unit 3 : Mutation and DNA repair

- (a) Nature of mutation - spontaneous and inducible mutation, mutation rate, mutagens, phenomic and phenotypic lag, phenotypic classes of bacterial mutants, methods of their isolation
- (b) Molecular basis of mutagenesis
 - Mode of action of some mutagens, base analogues, nitrous acid, alkylating agents, UV rays, Mu phage as a mutagen, Ames's test
 - Reversion of mutation- true reversion and suppression, types of suppressor mutations
- (c) DNA repair - direct and indirect repair mechanisms, post replicative and recombinational repair

Unit 4 : Genetic recombination and gene transfer in bacteria

- (a) Introduction to genetic recombination and its biological significance: Types of recombination and their molecular mechanisms - generalized, site specific and illegitimate recombination, recombination frequency and its significance
- (b) Modes of genetic transfer in bacteria - merodiploidic nature of bacterial zygote
 - Transformation : transformation principle, competence factor, mechanism of DNA uptake, transfection.
 - Transduction : phages involved in, types – restricted, generalized and abortive transduction
 - Conjugation: role of sex factor, types of crosses involved, F⁺ and Hfr cells. Mechanism of chromosomal transfer, interpreted mating and its applications, zygotic induction, sexduction
 - Plasmids and transposable elements as tools of gene transfer

Unit 5 : rDNA technology and genetic engineering

- (a) Introduction to genetic engineering, gene cloning and its ethical consideration
- (b) Outlines of rDNA technology and its application
- (c) Tools of genetic engineering/rDNA technology
 - Enzymes : restriction endonucleases, RNA polymerase, DNA ligase, alkaline phosphatase, reverse transcriptase.
 - Cloning vectors - plasmids, bacteriophages, cosmids, Ti, YEP
 - Genetic probe and PCR
- (d) Basic techniques of gene cloning in prokaryotes : brief outline
- (e) Site directed mutagenesis

Text Books

1. The microbial world, R.Y. Stanier, 5th ed. 1986
2. Principles of Microbiology, R. H. Atlas, 2nd ed., 1997
3. Microbiology, Prescott, Harley, Klein, 3rd and 5th ed., 1996 and 2002
4. Biotechnology, M. D. Trevan, 1987
5. Brock Biology of Microorganisms, Medigan *et al*, 8th and 9th ed., 1997, 2002

Paper VII : Bacterial Metabolism**Unit 1 : Energy, enzyme and regulation**

(a) Enzyme

- Enzyme kinetics - M.M. equation, Lineweaver Burk plot, K_m value, V_{max} , importance of K_m and V_{max} in understanding enzyme reaction
- Enzyme regulation : the nature and significance of metabolic regulations, metabolic channelling
- Allosteric regulation, allosteric site and its role.
- Feed back inhibition of metabolic pathways, patterns of regulation of branched chain pathway
- Other methods of control of enzyme activity - energy linked control, precursor activation, zymogen activation

(b) Energy

- Laws of Thermodynamics
- Free energy and reactions, E° value and its importance, oxidation-reduction reactions and electron carriers
- Mode of ATP formation and electron carriers
- Electron transport and oxidative phosphorylation, mechanism of generation of proton motive force
- Role of energy rich compounds

Unit 2 : Energy release and conservation

(a) Heterotrophic mode

- Breakdown of glucose under aerobic and anaerobic conditions
- Catabolism of other carbohydrate and intracellular reserve polymers
- Aerobic hydrocarbon degradation : β -keto adipate pathway
- Lipid catabolism : β -oxidation pathway
- Protein and amino acids catabolism
- TCA cycle and glyoxal bypass
- Anaerobic respiration
- Fermentation

(b) Chemoautotrophic mode

- Oxidation of inorganic molecules : hydrogen, iron, sulphur and nitrogen
- Role of reverse electron transport in generation of reducing power
- Photosynthesis : light reactions, comparative account of energy release in plant and bacterial photosynthesis

Unit 3 : The use of energy in biosynthesis

- Principles governing biosynthesis
- Photosynthetic fixation of carbondioxide
- Gluconeogenesis
- Assimilation of inorganic sulphur and nitrogen
- Anaplerotic reactions
- Lipid synthesis : synthesis of fatty acids and phospholipids
- Peptidoglycan synthesis

Unit 4 : Separation and analysis of metabolites and metabolic pathways

(a) Principles and applications of :

- Separation methods: Centrifugation, Chromatographic, Electrophoretic
- Analytical methods : Spectroscopic

- (b) Methods of studying biosynthesis
 - Isotopes and pulse labelling
 - Biochemical mutants
 - Metabolic inhibitors

Unit 5 : Biostatistics and bioinformatics

- (a) Biostatistics
 - Introduction of biostatistics, data and sampling
 - Graphical representation of data
 - Measures of central value– mean, median and mode
 - Measure of variability of data - standard deviation
- (b) Bioinformatics
 - Introduction
 - Importance and applications of bioinformatics
 - Computer : basics, basics of hardware and software
 - Uses of computer in biology and bioinformatics

Text Book

1. The microbial world. R.Y. Stanier, 5th ed. 1986.
2. Principles of Microbiology - R.M. Atlas, 2nd ed. 1997.
3. Microbiology - Prescott Harley, Klein 3rd & 5th ed. 1996 & 2002
4. Agricultural Statistics Techniques and Procedure, Mandal and Nambiar, 2002
5. Statistics and Experimental Design, G. M. Clarke, 1994.
6. Introduction to Microbiology, J. L. Ingraham and C. A. Ingraham, 2000.

Paper VIII : Immunology and Clinical Microbiology

Unit 1 : Immunity and immune response

- (a) Immunity - introduction, types of immunity - innate and acquired, active and passive, natural and artificial, herd immunity
- (b) Immune response
 - Antigen and immunogenicity: definition, character of immunogens, antigenic determinants, adjuvants, types of antigens, bacterial antigens
 - Immunoglobulins : general characters, basic structure of immunoglobulins, classes of Igs and their physico chemical and biological characteristics
 - Monoclonal antibodies and their applications
 - Immune response and immune system : nature of IR, primary and secondary IR, factors affecting. Immune system - peripheral and central lymphoid system. Lymphoid organs. Cells involved in IR, Clonal selection. Theory, basis of antibody diversity

Unit 2 : Dysfunctional immunity

- (a) Introduction, types, autoimmune disorders
- (b) Immuno deficiency - congenital and acquired
- (c) Hypersensitivity - introduction and types of hypersensitivity
- (d) Transplantation immunity - MHC antigens, Host vs graft and graft vs host reaction, immuno suppression
- (e) Tumour immunity

Unit 3 : Diagnostic immunology and prophylactic immunization

- (a) Diagnostic immunology : Antigen antibody reactions- Types, mechanism, zone phenomenon
 - *In vivo* antigen – antibody reactions, immune complex formation. Complement fixation – classical and alternate pathways, neutralization, virus neutralization, opsonization.
 - *In vitro* antigen antibody reactions : precipitation, agglutination, complement fixation, ELISA, RIA, RAST, immunofluorescence, Western Blot.
 - Measurement of CMI IR - MIF & MLR
 - Skin tests
- (b) Prophylactic immunization : Introductory characters and types of vaccines, schedule of vaccination, hazards of vaccination.

Unit 4 : Host parasite relationship and epidemiology

- (a) Normal flora of body – role, origin and establishment, normal flora of different systems, germ free animals and gnotobiosis.
- (b) Host Parasite interactions - dynamicity of host parasite relationship, factors affecting, infective process, types of infection, nosocomial infections.
- (c) Virulence of pathogenic organisms - Microbial factors – invasiveness and toxigenicity.
- (d) Host defences, non-specific host defences, general barriers – physical, chemical and biological, specific host defences.
- (e) Epidemiology and types of infection

Unit 5 : Clinical microbiology

- (a) General symptoms, transmission and control of bacterial infection of : skin, eye, respiratory tract, cardio-vascular system, nervous system, gastrointestinal tract, urinogenital tract.
- (b) Clinical microbiology :
 - Specimens
 - Identification of microorganisms from specimens : microscopic, growth and biochemical characteristics, phage typing, susceptibility testing, rapid identification techniques, molecular methods and metabolic products and name of serological/immunological techniques
- (c) Haematology :
 - Blood – its components, structure and function of blood cells, blood cell maturation.
 - Blood coagulation
 - Human blood group system
 - Principles of blood banking and safety in blood transfusion.

Text books

1. Principles of Microbiology, R.M. Atlas 2nd ed. 1997
2. Microbiology, Prescott, Harley, Klein, 3rd and 5th ed., 1996 and 2002
3. Microbiology – an introduction, Tortora , Funke, Case
4. Introduction to medical Laboratory technology Backer & Silverton

PAPER IX : VIROLOGY AND MYCOLOGY**Unit 1 : Viruses of eukaryotes**

- (a) Classification of animal viruses, enumeration and cultivation
- (b) Growth of animal viruses : adsorption, penetration and uncoating, intracellular development of DNA and RNA viruses.
- (c) Viruses- morphogenesis and release.
- (d) Cytopathic effect, transformation bodies, viral interference and interferon.
- (e) Persistent, latent and slow viruses. Prions, introduction to oncogenic viruses.
- (f) Introduction to plant viruses, TMV, viroids.

Unit 2 : Bacteriophages

- (a) One step growth curve, burst size.
- (b) Phage multiplication : T₄ Phage as the model system, phage adsorption and penetration, intracellular development. Early and late events, replication of phage chromosome, phage morphogenesis and release, phage ϕ_{174} .
- (c) Phage chromosome, phage mutants, host – induced modifications.
- (d) Temperate phages and lysogeny : general nature, Lambda phage as the model system. Mechanism of establishment of lysogeny. Molecular and genetic basis of establishment and maintenance of lysogeny. Induction of lysogeny. Phage- conversion, Replication of Lambda phage.
- (e) RNA phages, general nature, introduction to phage MS – 2.

Unit 3 : Fungi

- (a) General characters : somatic structure, ultra structure of fungal cell, hyphal modification.
- (b) Reproduction in fungi, fruiting bodies.
- (c) Mode of fungal nutrition : principles of cultivation, secondary metabolites of fungi and their importance
- (d) Mycotoxins – their types, aflatoxin
- (e) Fungal genetics : homo- and hetero thalidism, heterokaryosis, introduction to tetrad analysis, parasexual cycle

Unit 4 : Systematic mycology

- (a) Fungal classification, criteria used for classification
- (b) Habitat, morphology, reproduction and economic importance of : Slime molds, *Zygomycetes*, *Ascomycetes*, *Oomycetes*, *Basidiomycetes*, *Deuteromycetes*

Unit 5 : Human diseases caused by viruses and fungi

- (a) Viral diseases : etiology, symptoms, transmission, control and lab diagnosis of
 - Airborne diseases : Chicken Pox, Influenza, Mumps and Measles.
 - Arthropod borne diseases : Yellow fever, Dengue.
 - Food and waterborne disease : viral gastro-enteritis , Polio, Infectious Hepatitis
 - Direct contact diseases : AIDS, Herpes and Rabies.
- (b) Mycoses : superficial, cutaneous, subcutaneous and systemic mycoses.

Text Books

1. Principles of Microbiology, R.M. Atlas 2nd. Ed. 1997. Wm .C. Brown, London
2. Microbiology, Prescott, Harley, Klein, 3rd ed. 1996. Wm. C. Brown, London
3. The Microbial World. R.Y. Stanier. Et al, 5th Ed. 1986 Prentice – Hall, New Delhi
4. General Virology, Luria S.E. et al 3rd ed. 1978 John Wiley & Sons, NY
5. Microbiology – an introduction, Vol I and II, Tortora, Funke, Case 6TH Ed. 1998 Addison Wesley longman INC, NY
6. Introductory Mycology, Alexopoulos, 4th ed. 1995

Paper X : Industrial Microbiology

Unit 1 : Fermentation technology – I

- (a) Introduction to fermentation processes, concept of fermentation, range of fermentation processes, component parts.
- (b) Media for fermentation : raw materials used, formulation of media, criteria for selection on raw materials, media ingredients.
- (c) Sterilization :
 - Need for asepsis, protected fermentation
 - Media sterilization-use of high-pressure steam, D value and its significance, factors affecting, batch and continuous sterilization.
 - Air sterilization – theory of sterilization, methods, types of filters
 - Sterilization of fermenter : introduction to filter sterilization of media and exhaust air.
 - Principles and methods of development of seed culture – general principles involved in preparation of bacterial and fungal inoculum
- (d) Immobilization of cells and enzymes

Unit 2 : Fermentation technology – II

- (a) Bioreactors :
 - Basic functions, aseptic operation and containment
 - Aeration and agitation components – need for aeration and agitation, factors affecting its efficiency, KLa and its significance.
 - Achievement and maintenance of asepsis.
- (b) Introduction to scale up
- (c) Down stream processing
 - Introduction
 - Removal of microbial cells and suspended solids.
 - Introduction to principles of cell disruption methods – physical – chemical and enzymatic methods.
 - Concentration by solubilization, solvent extraction and precipitation.
 - Purification by crystallization, chromatographic methods and ultrafiltration.
 - Drying
 - Quality assurance – bioassay
- (d) Introduction to fermentation economics

Unit 3 : Isolation, preservation and improvement of industrially important microorganisms

- (a) Criteria for selection of industrially important organisms.
- (b) Screening methods – primary and secondary.

- (c) Principles involved in isolation methods.
- (d) Improvement of industrially important microorganisms:
 - Need for strain improvement
 - Strategies for strain improvement : selection, adaptation, mutation and rDNA techniques.

Unit 4 : Microbial processes - I

- Microorganisms involved, fermentation processes and product recovery of : penicillin, ethanol, citric acid, vitamin B₁₂, lysine, xanthan
- Biomass production : production of food and feed yeast

Unit 5 : Microbial processes - II

Microorganisms involved, processes and products

- Microbial production of enzymes - amylase and protease
- Applications of enzymes – therapeutic, analytical, manipulative and industrial.
- Bioextraction of metals
- Microbially enhanced oil recovery (MEOR)
- Microbial insecticides
- Biofertilizers

Text Books

1. Principles of fermentation technology Stanbury, Whitaker
2. Biotechnology, M.D. Trevan, 1987
3. Principles of microbiology, R.M. Atlas, 2nd edition, 1987
4. Biotechnology, Crueger and Crueger, 2nd ed., 2000

Reference Books

1. Gene – VI, Benjamin Lewine 1987
2. Molecular Biology of gene, Watson J.D.
3. Microbiology, Davis & others 4th ed. 1990
4. Principles of biochemistry, Lehninger, 2nd ed 1993
5. Biotechnology, Smith John, 3rd ed. 1996
6. Microbiology, Pelzar Chan & Kreig, 1993
7. Brock Biology of Microorganisms, Madigan et al, 10th ed., 2003
8. A biologist's guide to principles and techniques of practical biochemistry, ed. B. L. Williams and K. Wilson

Practicals**Unit 1 : Bacterial genetics and molecular biology**

- (a) Isolation of pigmentation mutants of *Serratia marcescens*
- (b) Study of UV survival in *E coli* by turbidometric method.
- (c) Detection of antibiotic and pigment marker
- (d) Isolation of nucleic acid, estimation of nucleic acid

Unit 2 : Bacterial metabolism

- (a) Quantitative analysis
 - Estimation of glucose by Cole's method
 - Estimation of glucose by Nelson Somogy's method

- Protein estimation by Folin's method
- Estimation of alcohol
- Estimation of streptomycin
- (b) Separation of amino acids by paper chromatography and TLC (slide method)
- (c) Demonstration of electrophoretic separation of serum proteins.

Unit 3 : Immunology and medical microbiology

- (a) Isolation and identification of following bacteria.
E. coli, Enterobacter aerogenes, Proteus vulgaris, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Shigella dysenteriae, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis, Bacillus megaterium, Bacillus cereus
- (b) Study of serological reactions
 - Agglutination reaction
 - Precipitation reaction
 - Demonstration of immunodiffusion and ELISA
- (c) Serodiagnosis of diseases
 - Serodiagnosis of enteric fever by using slide agglutination and double dilution techniques
 - Serodiagnosis of syphilis using RPR test
- (d) Study of antibiogram of pathogenic bacteria by using multidisc method.
- (e) Study of permanent slides of medically important organisms and vectors.
 - *Pneumococci, Spirochetes, Clostridium tetani, Mycobacterium tuberculosis, Plasmodium vivax*
 - Tick, mite, flea, head and body louse, female anopheles mosquito, bedbug.
- (f) Haematology :
 - Total count of RBC and WBC
 - Haemoglobin estimation
 - Differential count of WBCS.
 - Blood grouping – ABO and Rh.
 - Clinical biochemistry
 - Estimation of blood glucose by glucose oxidase method
 - Estimation of blood urea by DAM method
 - Urine analysis – physical, chemical and microscopic examinations.

Unit 4 : Virology and Mycology

- (a) Isolation and cultivation of yeasts and molds :
Yeasts, Rhizopus, Mucor, Aspergillus, Penicillium, Neurospora, Fusarium, Alternaria, Curvularia and Helminthosporium.
- (b) Measurement of growth of fungi *Aspergillus* in terms of dry and wet weight .
- (c) Study of permanent slides of fungi and their structures.
Uredospores, Aciospore, Teleospores, Picniospores, Haustoria, Zygote, Ascus and clamp connection
- (d) Isolation of bacteriophages from sewage

Unit 5 : Industrial Microbiology

- Primary screening of industrially important microorganisms capable of producing : antibiotics, organic acids, enzymes
- Bioassay of penicillin using *B. subtilis*

- Sterility testing of pharmaceutical products
- Fermentative production of amylase and determination of amylase activity
- Determination of oxygen transfer rate by sodium sulphite method

NOTE

- Visit to public health laboratory, drug laboratory, research institutes and fermentation industries will be under taken during the year.
- Candidate is required to bring for inspection the practical journal duly signed and certified by the head of the department during practical examination.
- Viva-voce will be illustrative of theoretical portion of syllabus.
- The marks distribution and scheme of exercise will be as follows.
- In theory question paper there could be maximum one full question, maximum one question with 3 options and rest with 2 options.
- Equal weightage will be given to each option for practicals.

Scheme of Practical Examination**Marks****Paper I**

1. Isolation and Identification	35
2. Viva voce	10
3. Journal and slides	10

Paper II

4. Genetics or Metabolism	30
5. Spotting	20
6. Viva voce	10

Paper III

7. Industrial or Virology or Mycology	30
8. Clinical or Haematology or Serology or Sensitivity testing	30

Total Marks 175